I, Tadahiko Itoh, a Patent Attorney of Tokyo, Japan having my office at 32nd Floor, Yebisu Garden Place Tower, 20-3, Ebisu 4-chome, Shibuya-ku, Tokyo 150-6032, Japan do solemnly and sincerely declare that I am the translator of the attached English translation and certify that the attached English translation is a correct, true and faithful translation of the Japanese Patent Application No. H11-345075 to the best of my knowledge and belief.

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(54) [Title of the Invention] Information recording/reproducing apparatus
(57) [Abstract]
[Objective] To enable tilt adjustment without decreasing robustness for supporting an optical disc or an optical pickup.
[Solutions] One side of a rotating chassis 8 is made rotatable in a vertical direction as shown by an arrow A by causing a first pivot receiving member 13 to rotate. Also, another side of the rotating chassis 8 is fixed by fixing a second pivot receiving member 14. Thus, the rotating chassis 8 may be tilted. The tilt direction of the chassis 8 is a direction moving about the line perpendicular to a line connecting the both pivots 10 and 11, that is, a tangential tilt adjusting direction with respect to the optical pickup.
[Scope of Claims]
[Claim 1]
An information recording/reproducing apparatus comprising:

a spindle motor for rotating an optical disc;
an optical pickup for irradiating a laser beam to form a light spot on the optical disc so as to record or reproduce information; and
a seek mechanism for driving the optical pickup in a radial direction of the optical disc,
the information recording/reproducing apparatus being characterized in that the spindle motor is held with a base member, and the seek mechanism is held so as to be freely titled with respect to the base member using two support mechanisms provided to the base member, wherein one of the two support mechanisms is vertically movable in the direction of the thickness of the optical disc, whereby a tilt of the optical pickup with respect to the optical disc is adjusted.

[Claim 2]

The information recording/reproducing apparatus as claimed in claim 1, characterized in that the one of the support mechanisms which is vertically movable in the direction of the thickness of the optical disc and adjusts a tilt of the optical pickup with respect to the optical disc, is provided farther to an objective lens in the radial direction of the optical disc than another one of support mechanisms is.

[Claim 3]

An information recording/reproducing apparatus comprising:
a spindle motor for rotating an optical disc;
an optical pickup for irradiating a laser beam to form a light spot on the optical disc so as to record or reproduce information; and
a seek mechanism for driving the optical pickup in a radial direction of the optical disc,
the information recording/reproducing apparatus being characterized in that the spindle motor is held with a base member, and the seek mechanism is held so as to be freely titled with respect to the base member using two support mechanisms provided to the base member, wherein the both support mechanisms are vertically movable in the direction of the thickness of the optical disc, whereby a tilt of the optical pickup with respect to the optical disc is adjusted by vertically moving one of the support mechanisms, and a height of the optical pickup with respect to the optical disc is adjusted by vertically moving the both support mechanisms.

[Claim 4]

The recording/reproducing apparatus as claimed in claim 1, 2 or 3, characterized in that male screw portions provided in pedestals

included in the support mechanisms engage with female screw portions formed in the base member so as to be vertically movable; and the male screw portions are turned so that the pedestals are vertically movable in the direction of the thickness of the optical disc.

[Claim 5]

The recording/reproducing apparatus as claimed in claim 1, 2 or 3, characterized in that the pedestals forming the support mechanisms which are vertically movable in the direction of the thickness of the optical disc are provided with male screw portions and cylinder portions, and that the base member is provided with female screw portions with which the male screw portions engage and opening portions which the cylinder portions fit into.

[Claim 6]

The recording/reproducing apparatus as claimed in claim 4 or 5, characterized by comprising an elastic member interposed between the base member and the pedestal.

[Detailed Description of the Invention]

[0001]

The present invention relates to an optical disc driver including an optical pickup that is capable of recording, reproducing and erasing information by irradiating a light beam to form a light spot on an optical disc such as a CD, a DVD or the like, and, in particular, relates to an information recording/reproducing apparatus capable of adjusting a tilt and height of the optical pickup with respect to the optical disc.

[0002]

[Background Art]

Optical discs have been shifting from CDs to DVDs recently. A DVD has a storage capacity approximately seven times as large as that of a CD. To comply with the increase in the storage capacity, a light beam to be irradiated to the optical disc needs to be reduced. Thus, a wavelength of a laser beam of a semiconductor laser is reduced, and a numerical aperture (NA) of an objective lens is increased. The increased NA causes a tilt of the objective lens with respect to the optical disc to be a critical issue.

[0003]

Specifically, if the objective lens is tilted with respect to the optical disc, a coma aberration occurs in the beam spot. The larger the numerical aperture is, the more easily the coma aberration occurs. The coma aberration deteriorates performance of the beam spot, thus causing a worsened jitter (instability of information data in its time-axial direction) at a time of reproduction.

[0004]
Therefore, a common DVD driver is generally provided with adjustment of a tilt angle formed between an optical disc and an objective lens. As to the adjustment means, numerous techniques have been already applied for a patent, including, for example, Japanese Patent Laid-open Publication Nos. 10-69650, 10-112122, and 10-208372 each disclose a recording/reproducing apparatus which mounts a spindle motor on a plate capable of adjusting a tilt with respect to a base member, thereby enabling tilt adjustment.
[0005]
Further, Japanese Patent Laid-open Publication Nos. 11-25466 and 11-149724 each disclose a recording/reproducing apparatus which adjusts a tilt of a guide shaft which guides movements of an optical pickup in the radial direction of an optical disc.
[0006]
That is, these prior art technologies are roughly divided into two types of structures: a structure to adjust a spindle motor on which an optical disc is placed and another structure to adjust an optical pickup which includes an objective lens.
[0007]
[Problems to be Solved by the Invention]
In the aforementioned conventional technologies, the former structure has a drawback that the support robustness of the spindle motor is reduced because the spindle motor is not directly fixed to the base member. Therefore, when the optical disc is rotated, strong vibrations occur due to a rotational movement of the spindle motor. A DVD drive is also used for recording and reproducing the CDs. The rotational speed of the recent CD drive is very high and a maximum rotational speed of such CD drive is approximately 10,000 rpm. The spindle motor which rotates at such a high speed needs to be supported rigidly, and if not supported with a high rigidity, vibration occurs in the disc or in the optical pickup, thereby causing the recording/reproducing operation to be unstable. In addition, if a CD or a DVD has an eccentricity, a strong vibration occurs. In such a case, if the support robustness of the spindle motor is low, a great vibration occurs and transmitted to the optical disc or the optical pickup, which may cause a critical problem.
[0008]
Further, the optical disc is tilted by tilt-adjusting the spindle motor. Therefore, in the case of using a cartridge housing an optical disc, the optical disc may touch the inner wall of the cartridge by being tilt-adjusted in the cartridge.

[0009]
Further, in the latter structure, the guide shaft, which is a seek-type guide unit for driving the optical pickup in a radial direction of an optical disc for an access operation of the optical pickup, is tilted. However, since guide rails are not directly fixed to a base member, rigidity for supporting the optical pickup is reduced. Therefore, there is a problem that the vibration during a high-speed access operation of the optical pickup is large.
[0010]
It is a main object of the present invention to provide an information recording/reproducing apparatus in which the above-described conventional disadvantages are eliminated and tilt adjustment is enabled without reducing the support robustness of the optical pickup.
[0011]
[Means for Solving the Problems]
In order to achieve the above objectives, the present invention is to provide an information recording/reproducing apparatus including a spindle motor for rotating an optical disc; an optical pickup for irradiating a laser beam to form a light spot on the optical disc so as to record or reproduce information; and a seek mechanism for driving the optical pickup in a radial direction of the optical disc, and the information recording/reproducing apparatus is characterized in that the spindle motor is held with a base member, and the seek mechanism is held so as to be freely titled with respect to the base member using two support mechanisms provided to the base member. The information recording/reproducing apparatus is also characterized in that one of the two support mechanisms is vertically movable in the direction of the thickness of the optical disc, whereby a tilt of the optical pickup with respect to the optical disc is adjusted.
[0012]
Further, in the present invention, the information recording/reproducing apparatus is characterized in that the one of the support mechanisms which is vertically movable in the direction of the thickness of the optical disc and adjusts a tilt of the optical pickup with respect to the optical disc, is provided farther to an objective lens in the radial direction of the optical disc than another one of support mechanisms is. Thus, the displacement of the optical pickup in the direction of the thickness of the optical disc during the adjustment operation may be minimum.
[0013]

Furthermore, the present invention is directed to an information recording/reproducing apparatus including a spindle motor for rotating an optical disc; an optical pickup for irradiating a laser beam to form a light spot on the optical disc so as to record or reproduce information; and a seek mechanism for driving the optical pickup in a radial direction of the optical disc, and the information recording/reproducing apparatus is characterized in that the spindle motor is held with a base member, and the seek mechanism is held so as to be freely titled with respect to the base member using two support mechanisms provided to the base member. The information recording/reproducing apparatus is further characterized in that the both support mechanisms are vertically movable in the direction of the thickness of the optical disc, whereby a tilt of the optical pickup with respect to the optical disc is adjusted by vertically moving one of the support mechanisms, and a height of the optical pickup with respect to the optical disc is adjusted by vertically moving the both support mechanisms.

[0014]

Moreover, the present invention is directed to the recording/reproducing apparatus characterized in that male screw portions provided in pedestals included in the support mechanisms engage with female screw portions formed in the base member so as to be vertically movable; and the male screw portions are turned so that the pedestals are vertically movable in the directions of the thickness of the optical disc. Thus, the structure of the support mechanisms vertically movable in the direction of the thickness of the optical disc may be simplified.

[0015]

In addition, the present invention is directed to the recording/reproducing apparatus characterized in that the pedestals forming the support mechanisms which are vertically movable in the direction of the thickness of the optical disc are provided with male screw portions and cylinder portions, and that the base member is provided with female screw portions with which the male screw portions engage and opening portions which the cylinder portions fit into. Accordingly, fluctuations, deviations and rattling of the not-adjusted-parts during the displacement may be eliminated and shifting of the optical axis of the pickup may be reduced.

[0016]

Also, the present invention is directed to the recording/reproducing apparatus characterized by including an elastic member interposed between the base member and the pedestal.

By using the elastic member, fluctuations, deviations and rattling movement in the displacement may be absorbed and thus, shifting of the optical axis of the pickup may be reduced.

[0017]

[Preferred Embodiments of the Invention]

Preferred embodiments of the present invention will now be described with reference to the drawings.

[0018]

Fig. 1 is a plan view showing a seek mechanism of a recording/reproducing apparatus for explaining a first embodiment of the present invention. Fig. 2 is an exploded perspective view of the seek mechanism showing an adjustment structure thereof in the first embodiment.

[0019]

In Fig. 1, a reference numeral 1 is a spindle motor which is fixed to a fixed chassis, a base member to be described later. The spindle motor rotatably drives an optical disc, not shown. A reference numeral 2 is an optical pickup of a known structure, having an objective lens 3 for focusing a light beam to form a light spot on the optical disc during recording, reproducing and erasing information, and having a light receiving element, not shown, for receiving a reflected light from the optical disc. Reference numerals 4, 4 are guide rails for guiding the optical pickup 2 to move to a seek direction, and a reference numeral 5 is a lead screw which is formed with a spiral screw groove 5a with which a connecting claw portion, not shown, is engaged and rotates in a circumferential direction to thereby move the optical pickup 2. A reference numeral 6 is a seek motor which provides a rotating driving force to the lead screw 5 via gears 7, and a reference numeral 8 is a rotating chassis which holds the guide rails 4, 4, the lead screw 5 and the seek motor 6.

[0020]

As shown in Fig. 2, a first and second pivot portions 10 and 11 are formed on both sides of the rotating chassis 8 to serve as a support mechanism by being oppositely positioned in a direction perpendicular to the seek direction. The both pivot portions 10 and 11 are supported by the fixed chassis 12, which is a base member to which the spindle motor 1 is fixed, and support the rotating chassis 8 so that the rotating chassis 8 is movable in its rotational direction about a line connecting the first and second pivot portions 10 and 11. The fixed chassis 12 includes holding arm portions 15 and 16 for holding a cylinder-like first pivot receiving member 13 and a rectangular second pivot receiving member 14, respectively. The pivot portions 10 and 11 are pressed

against the pivot receiving members 13 and 14 respectively by pressure-springs 17 and 18 which are fixed to the fixed chassis 12.

[0021]

A driven portion 20 is provided at a corner of the rotating chassis 8. The driven portion 20 contacts a cam surface 21a of a driving cam 21, which is rotated by a drive source (not shown). The height of the cam surface 21a varies. The driven portion 20 is pressed against the cam surface 21a of the driving cam 21 by a pressure-spring 22 fixed to the fixed chassis 12.

[0022]

Fig. 3 is an enlarged cross-sectional view of the support mechanism of the pivot portion 10 according to the first embodiment. The first pivot-receiving member 13 includes a head portion 26 having a concave portion 25 formed in its top portion and a male screw portion 27 formed under the head portion 26. A drooping pin 28, which extends in a downward direction of the pivot portion 10, is placed in the concave portion 25. The upper surface of the drooping pin 28 is pressed in the downward direction by the pressure spring 17. The male screw portion 27 engages with a female screw portion 29 formed in the holding arm portion 15 of the fixed chassis 12 so as to be movable in upward and downward directions.

[0023]

Therefore, in the first embodiment, by rotating the first pivot-receiving member 13, the first pivot-receiving member 13 can be moved in vertical directions as indicated by an arrow A in Fig. 2. At this point, by keeping the second pivot-receiving member 14 fixed, the rotating chassis 8 is tilted. Directions in which the rotating chassis 8 is tilted are the rotational directions in which the rotating chassis 8 is movable about the line perpendicular to the line connecting the first and second pivot portions 10 and 11, that is, the directions of a tangential tilt adjustment with respect to the optical pickup 2.

[0024]

Thus, according to the first embodiment, without including any special mechanism, the tangential tilt adjustment can be made only by changing the structure of one of the support mechanisms in the conventional radial tilt servo mechanism. Since the load of a tangential tilt mechanism does not cause the support robustness of the optical disc or the optical pickup to be deteriorated, the high-speed rotation of the disc or the high-speed access of the optical pickup 2 is not prevented.

[0025]

Fig. 4 is an enlarged cross-sectional view of a support mechanism according to a second embodiment of the present invention. In Fig. 4, the same elements as those described in the first embodiment are applied with the same reference numerals, and a detailed description thereof will be omitted.

[0026]

The second embodiment is different from the first embodiment in the following points: that is, a cylinder portion 30 is provided between the head portion 26 and the male screw portion 27 of the first pivot-receiving member 13, and, at an upper portion of the male screw portion 29 provided to the holding arm portion 15 of the fixed chassis 12, an opening portion 31 having a circular cross section is formed to engage with the cylinder portion 30 of the first pivot-receiving member 13 to secure the position of the cylinder portion 30.

[0027]

Therefore, according to the second embodiment, when the male screw portion 27 of the first pivot-receiving member 13 is screwed into the female screw portion 29 of the fixed chassis 12, the male screw portion 27 is properly screwed into the female screw portion 29 owing to a guide effect of the cylinder portion 30 and the opening portion 31, thus preventing the rotating chassis 8 from moving in a direction other than the direction in which the male screw portion 27 is screwed. Therefore, at a time of the tangential tilt adjustment, the rotating chassis 8 is prevented from being inadvertently moved in the directions of the thickness of the optical disc (i.e., a focusing direction) or in the radial direction of the optical disc (i.e., a tracking direction).

[0028]

Fig. 5 is an enlarged cross-sectional view of a support mechanism for explaining a third embodiment of the present invention. The parts corresponding to those described in the first and second embodiments are referred to with the same reference numerals, and a detailed description thereof will be omitted.

[0029]

The third embodiment is different from the second embodiment in the following points: that is, between a bottom portion of the head portion 26 and an upper portion of the opening portion 31 of the first pivot-receiving member 13, an elastic member 35 including a spring washer, a leaf spring, and a coil spring is interposed.

[0030]

Therefore, according to the structure of the third embodiment, when the male screw portion 27 of the first pivot-receiving member

13 is screwed into the female screw portion 29 of the fixed chassis 12, the elastic member 35 is held and bent between the lower portion of the head portion 26 and the upper portion of the opening portion 31, thus causing to generate a pressing force to press the first pivot-receiving member 13 and the fixed chassis 8 with each other. Therefore, the thread ridges of the male screw portion 27 and the female screw portion 29 are pressed with each other, thereby eliminating a backlash in the engagement portion. Thus, the instability after the tangential tilt adjustment may be eliminated.

[0031]

In the aforementioned respective embodiments, as shown in Fig. 1, if a distance between the first pivot portion 10 and the objective lens 3 of the optical pickup 2 is set as L1, and a distance between the second pivot portion 11 and the objective lens 3 is set as L2, those distances are set to satisfy a condition L1>L2.

[0032]

Fig. 6 is a conceptual diagram showing positional relations among the first and second pivot portions 10 and 11, and the objective lens 3. When the respective members are located with the distances L1 and L2 as described above, the first pivot portion 10 needs to be moved by a distance X1 so that the tangential tilt adjustment of an angle B is made. The direction of the move is the direction of the thickness of the optical disc (i.e., the focusing direction). By this tangential tilt adjustment, the objective lens 3 can be moved by a distance X2 in the focusing direction. The distance X2 is given by the following formula:

[0033]

[Formula 1] $X2=L2/(L1+L2) \times X1$

An actuator performs a focusing operation so that the laser beam is focused onto the optical disc through the objective lens 3. Therefore, if a distance X2 is large, a moving distance of the actuator during focusing operation becomes large, thereby causing to make the recording/reproducing apparatus larger or thicker. For this reason, the distance X2 needs to be kept minimum.

[0034]

However, according to the present embodiments, since the distances L1 and L2 are determined to satisfy the condition L1>L2 as described above, the moving distance X2 of the objective lens 3 may be kept minimum. In contrast, if the distances L1 and L2 are determined to satisfy a condition L1<L2, the moving distance X2 of the objective lens 3 will be longer as is apparent from the above formula 1.

[0035]

Fig. 7 is an enlarged sectional view of a principal part of a recording/reproducing apparatus according to a fourth embodiment of the present invention. The same members as those described in the first through third embodiments are referred to with the same reference numerals, and a detailed description thereof will be omitted.

[0036]

According to the fourth embodiment, the above-described vertically movable support mechanism is adopted in both of the first and second pivot portions 10 and 11. In the present embodiment, an example in which the both pivot portions 10 and 11 are applied with the support mechanism for the third embodiment is shown.

[0037]

Therefore, according to the fourth embodiment, the tangential tilt adjustment can be made by moving and adjusting one of the first pivot-receiving members 13 of the respective first and second pivot portions 10 and 11. Further, a height of the rotating chassis 8 can be adjusted by moving and adjusting the first pivot-receiving members 13 of the respective first and second pivot portions 10 and 11.

[0038]

In addition, by adjusting the height of the rotating chassis 8, an error in a distance between heights of the optical disc and the optical pickup 2 caused by irregularity of components and unevenness in assembling the components, may be reduced. Thus, the recording/reproducing apparatus can be made thinner.

[0039]

[Effects of the Invention]

As aforementioned, according to the present invention, a tilt adjustment of the optical pickup with respect to the optical disc and a height adjustment of the optical pickup with respect to the optical disc are enabled. In addition, without adding any special mechanism, only by changing a structure of one of supporting mechanisms in the conventional radial tilt servomechanism, a tangential tilt adjustment may be enabled. Due to such a mechanism, supporting robustness of the disc or of the optical pickup may not be reduced due to a load of the tangential tilt mechanism, and thus, a favorable effect that the higher rotational speed of the disc or higher access of the pickup may not be prevented, may be obtained.

[Brief Description of the Drawing]

[Fig. 1]

Fig. 1 is a plan view showing a seek mechanism of a

recording/reproducing apparatus for explaining a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is an exploded perspective view showing an adjusting structure of the seek mechanism in the first embodiment of the present invention.

[Fig. 3]

Fig. 3 is an enlarged cross-sectional view showing a pivot portion of the support mechanism in the first embodiment of the present invention.

[Fig. 4]

Fig. 4 is an enlarged cross-sectional view of a support mechanism for explaining a second embodiment of the present invention.

[Fig. 5]

Fig. 5 is an enlarged cross-sectional view of a support mechanism for explaining a third embodiment of the present invention.

[Fig. 6]

Fig. 6 is a diagram conceptually showing positional relations among first and second pivot portions, and an objective lens in the embodiments of the present invention.

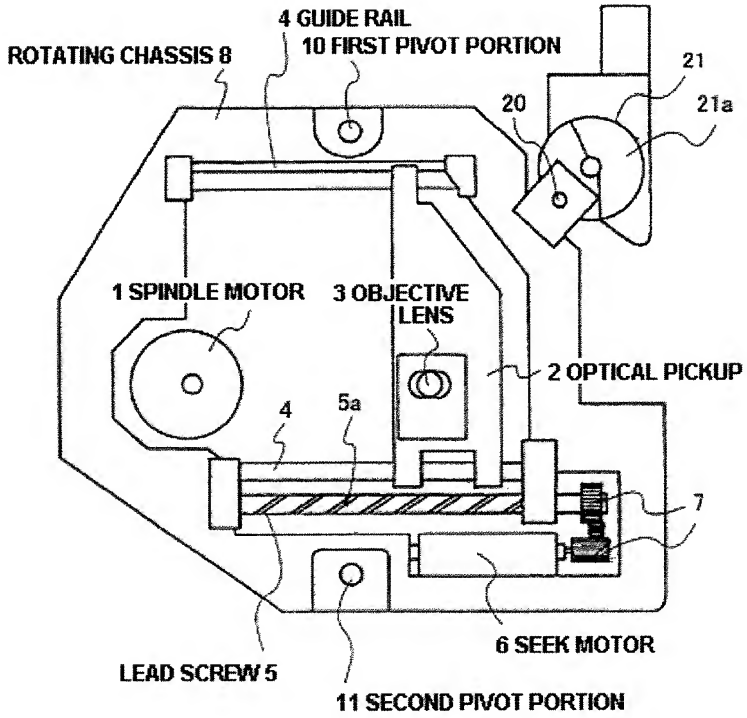
[Fig. 7]

Fig. 7 is an enlarged sectional view of a support mechanism for explaining a fourth embodiment of the present invention.

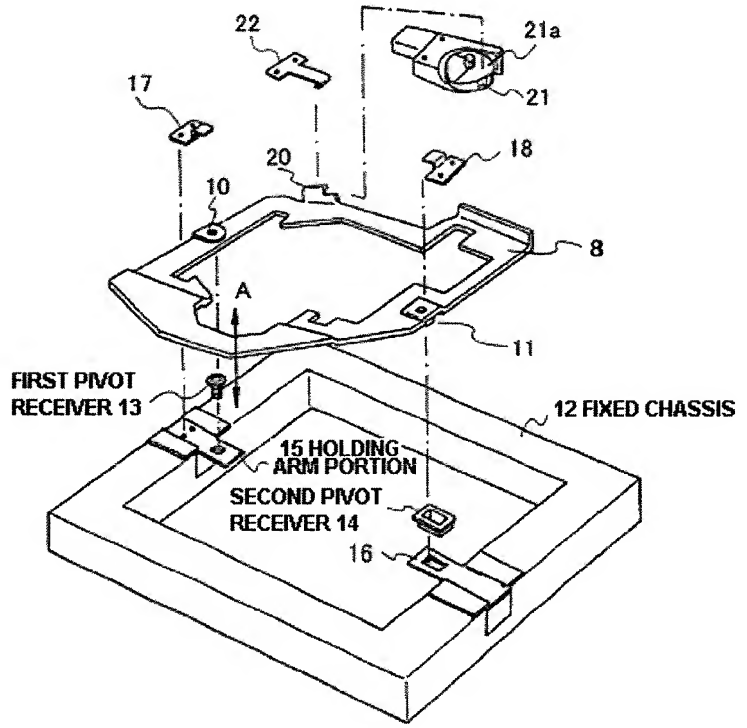
[Reference Numerals]

1 Spindle motor
2 Optical pickup
3 Objective lens
4 Guide rail
5 Lead screw
6 Seek motor
8 Rotating chassis
10, 11 Pivot portion
12 Fixed chassis
13, 14 Pivot receiver
15, 16 Holding arm portion
27 Male screw portion
28 Drooping pin
29 Female screw portion
30 Cylinder portion
31 Opening portion
35 Elastic member

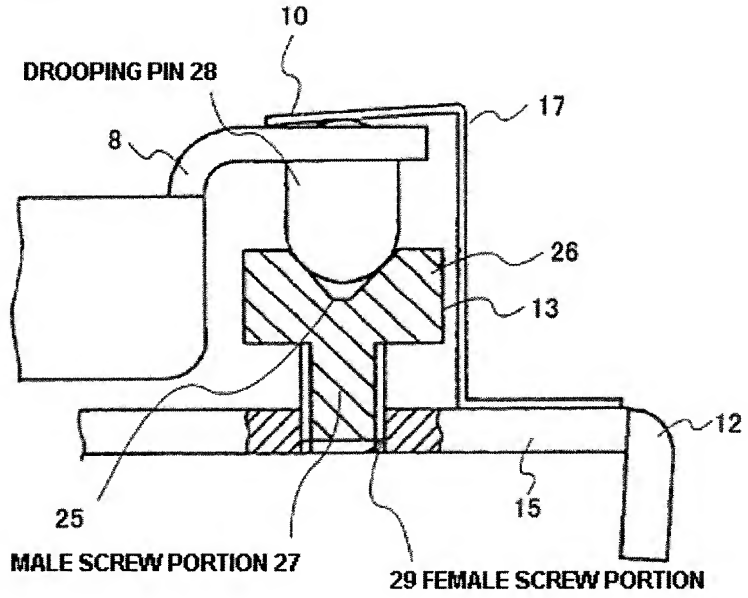
[Fig. 1]


4 GUIDE RAIL
10 FIRST PIVOT PORTION
ROTATING CHASSIS 8
21
21a
20
1 SPINDLE MOTOR
3 OBJECTIVE LENS
2 OPTICAL PICKUP
4
5a
7
6 SEEK MOTOR
LEAD SCREW 5
11 SECOND PIVOT PORTION

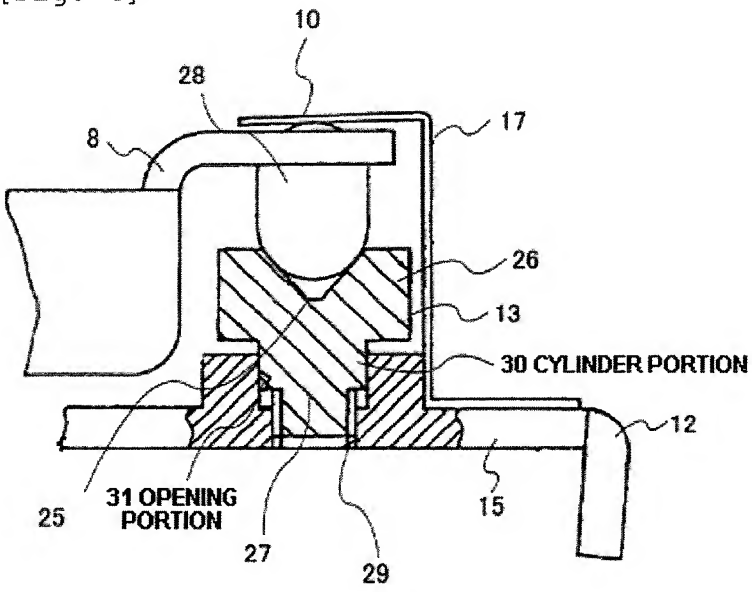
[Fig. 2]


22
21a
17
21
18
20
10
8
A
11
FIRST PIVOT RECEIVER 13
12 FIXED CHASSIS
15 HOLDING ARM PORTION
SECOND PIVOT RECEIVER 14
16

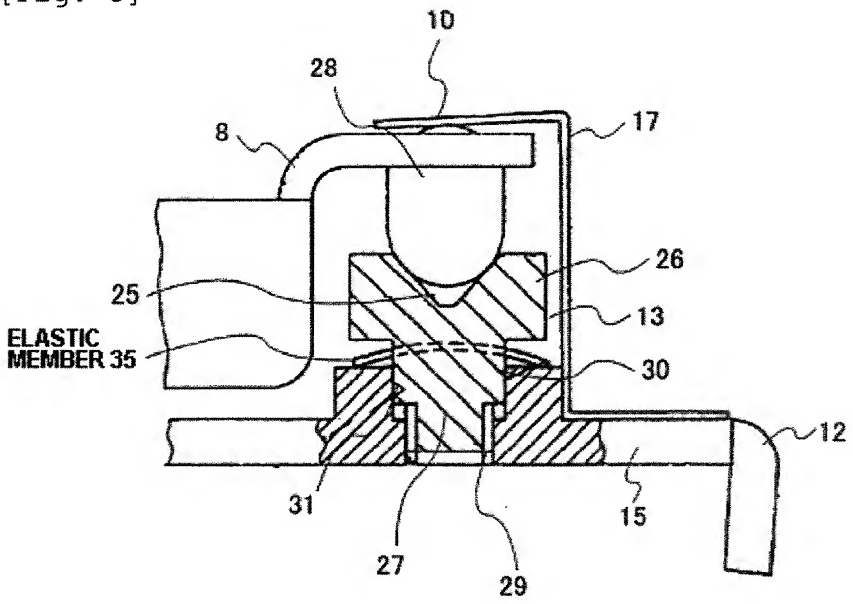
[Fig. 3]


10
DROOPING PIN 28
17
8
26
13
12
25
15
MALE SCREW PORTION 27
29 FEMALE SCREW PORTION

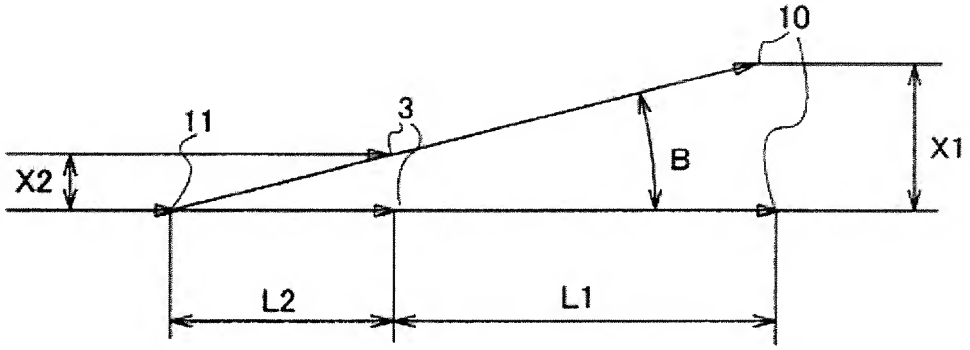
[Fig. 4]


10
28
17
8
26
13
30 CYLINDER PORTION
12
25
31 OPENING PORTION
27
29
15

[Fig. 5]



[Fig. 6]



[Fig. 7]